

Reusable Solid Rocket Motor – V (RSRMV) Nozzle Forward Nose Ring Thermo-Structural Modeling

J. Louie Clayton
NASA - Marshall Space Flight Center
Redstone Arsenal, Alabama

During the developmental static fire program for NASAs Reusable Solid Rocket Motor-V (RSRMV), an anomalous erosion condition appeared on the nozzle Carbon Cloth Phenolic nose ring that had not been observed in the space shuttle RSRM program. There were regions of augmented erosion located on the bottom of the forward nose ring (FNR) that measured nine tenths of an inch deeper than the surrounding material. Estimates of heating conditions for the RSRMV nozzle based on limited char and erosion data indicate that the total heat loading into the FNR, for the new five segment motor, is about 40-50% higher than the baseline shuttle RSRM nozzle FNR. Fault tree analysis of the augmented erosion condition has lead to a focus on a thermo-mechanical response of the material that is outside the existing experience base of shuttle CCP materials for this application. This paper provides a sensitivity study of the CCP material thermo-structural response subject to the design constraints and heating conditions unique to the RSRMV Forward Nose Ring application. Modeling techniques are based on 1-D thermal and porous media calculations where in-depth interlaminar loading conditions are calculated and compared to known capabilities at elevated temperatures. Parameters such as heat rate, in-depth pressures and temperature, degree of char, associated with initiation of the mechanical removal process are quantified and compared to a baseline thermo-chemical material removal mode. Conclusions regarding postulated material loss mechanisms are offered.